

## CLAIMS

1. A magneto-resistance device comprising:  
an anti-ferromagnetic layer;  
a pinned ferromagnetic layer coupled with said  
5 anti-ferromagnetic layer such that a direction of  
spontaneous magnetization of said pinned ferromagnetic  
layer is fixed;  
a non-magnetic tunnel insulating layer coupled  
with said pinned ferromagnetic layer; and  
10 a free ferromagnetic layer coupled with said  
tunnel insulating layer and having a reversible free  
spontaneous magnetization,  
wherein said pinned ferromagnetic layer  
comprises a first composite magnetic layer configured  
15 to prevent at least one of elements of said anti-  
ferromagnetic layer from diffusing into said tunnel  
insulating layer.
2. The magneto-resistance device according to  
20 claim 1, wherein said anti-ferromagnetic layer  
contains Mn, and  
said first composite magnetic layer prevents  
said Mn from diffusing into said tunnel insulating  
film.
- 25 3. The magneto-resistance device according to  
claim 1 or 2, wherein said first composite magnetic

layer comprises:

ferromagnetic material that has been not oxidized; and

oxide of a material which is easy to bind with  
5 oxygen compared with said ferromagnetic material.

4. The magneto-resistance device according to claim 3, wherein said ferromagnetic material contains Co in as a main component.

10

5. The magneto-resistance device according to any of claims 1 to 4, wherein said first composite magnetic layer is formed from a region of an amorphous phase as a whole or from a region of said amorphous  
15 phase and a region of a crystalline phase.

6. The magneto-resistance device according to claim 5, wherein said crystalline phase region contains a plurality of crystal regions, and  
20 said plurality of crystal regions pass through said first composite magnetic layer into a direction of a thickness of said first composite magnetic layer.

7. The magneto-resistance device according to  
25 claim 5 or 6, wherein a composition of said amorphous phase in said first composite magnetic layer is  $D_zM_{1-z}O_x$  ( $0.6 \leq z \leq 0.9$ , and  $x > 0$ ),

said D is at least one selected from the group consisting of Co, Fe and Ni, and

said M is at least one selected from the group consisting of Ta, Zr, Hf, Nb, and Ce.

5

8. The magneto-resistance device according to any of claims 1 to 4, wherein said first composite magnetic layer contains a plurality of crystal grains comprising said ferromagnetic material,

10 said plurality of crystal grains are separated from each other by said oxide, and

a part of said plurality of crystal grains contacts an adjacent one of said plurality of crystal grains.

15

9. The magneto-resistance device according to claim 8, wherein said oxide comprises oxide of at least an element selected from the group consisting of Al, Si, Mg and Ti.

20

10. The magneto-resistance device according to any of claims 1 to 4, wherein said first composite magnetic layer contains a plurality of crystal grains comprising said ferromagnetic material, and

25 said plurality of crystal grains are separated from each other by said oxide and pass through said first composite magnetic layer into a direction of a

thickness of said first composite magnetic layer.

11. The magneto-resistance device according to claim 10, wherein a part of said plurality of crystal  
5 grains contacts an adjacent one of said plurality of crystal grains.

12. The magneto-resistance device according to claim 10 or 11, wherein said oxide comprises oxide of  
10 at least an element selected from the group consisting of Al, Si, Mg, Ti, Ta, Hf, Zr, Nb and Ce.

13. The magneto-resistance device according to any of claims 8 to 12, wherein a thickness of said oxide  
15 is thinner than a grain diameter of each of said plurality of crystal grains.

14. The magneto-resistance device according to claim 13, wherein the thickness of said oxide is equal  
20 to or less than 2 nm.

15. The magneto-resistance device according to claim 14, wherein an average grain diameter of said plurality of crystal grains is equal to or less than  
25 10 nm.

16. The magneto-resistance device according to any

of claims 8 to 15, wherein ferromagnetic coupling is kept between said plurality of crystal grains.

17. The magneto-resistance device according to any  
5 of claims 1 to 16, wherein said pinned ferromagnetic layer further comprises a first metal ferromagnetic layer and a second metal ferromagnetic layer, and  
said first composite magnetic layer is  
interposed between said first metal ferromagnetic  
10 layer and said second metal ferromagnetic layer.

18. The magneto-resistance device according to any  
of claims 1 to 17, wherein a resistivity of said first  
composite magnetic layer is in a range of 10  $\mu\Omega\text{cm}$  to  
15 3000  $\mu\Omega\text{cm}$ .

19. The magneto-resistance device according to any  
of claims 1 to 18, wherein said free ferromagnetic  
layer comprises:  
20 a second composite magnetic layer configured to  
prevent at least one elements of said free  
ferromagnetic layer from diffusing into said tunnel  
insulating layer.

25 20. The magneto-resistance device according to  
claim 19, wherein said free ferromagnetic layer  
contains Ni, and

said second composite magnetic layer prevents said Ni from diffusing into said tunnel insulating film.

5 21. The magneto-resistance device according to claim 20, wherein said free ferromagnetic layer comprises:

a metal ferromagnetic layer, one of whose boundaries is connected to said tunnel insulating  
10 layer and the other of whose boundaries is connected to said second composite magnetic layer; and

a soft magnetic layer containing said Ni and connected to a boundary of said second composite magnetic layer which is an opposite side to said metal  
15 ferromagnetic layer.

22. The magneto-resistance device according to claim 1 or 2, wherein said pinned ferromagnetic layer comprises:

20 a non-magnetic layer; and  
two ferromagnetic layers anti-ferromagnetically coupled to each other through said non-magnetic layer.

23. The magneto-resistance device according to  
25 claim 19 or 20, wherein said free ferromagnetic layer comprises:

a non-magnetic layer; and

two ferromagnetic layers anti-ferromagnetically coupled through said non-magnetic layer.

24. A magnetic memory comprising:

5 said magneto-resistance device according to any of claims 1 to 23.

25. A method of manufacturing of a magneto-resistance device, comprising:

10 forming the anti-ferromagnetic layer containing Mn above a substrate;

forming a pinned ferromagnetic layer with a fixed spontaneous magnetization on said anti-ferromagnetic layer, wherein said pinned ferromagnetic  
15 layer comprises a first composite magnetic layer to prevent said Mn from diffusing into a tunnel insulating layer;

forming said non-magnetic tunnel insulating layer on said pinned ferromagnetic layer; and

20 forming a free ferromagnetic layer with a reversible free spontaneous magnetization on said tunnel insulating layer, and

wherein said first composite magnetic layer is formed to have ferromagnetic material, which has been  
25 not oxidized, as a main component and oxide of material which has easiness of binding with oxygen equal to or more than said ferromagnetic material as a

sub component.

26. The method of manufacturing the magneto-  
resistance device according to claim 25, wherein said  
5 forming a pinned ferromagnetic layer comprises:

forming said first composite magnetic layer by  
carrying out reactive sputtering in a mixed atmosphere  
of an inactive gas and an oxygen gas by using a target  
which contains at least one ferromagnetic material  
10 selected from the group consisting of Co, Ni and Fe  
and at least one non-magnetic material selected from  
the group consisting of Al, Si, the Mg, Ti, Ta, Hf,  
Zr, Nb and Ce.

15 27. The method of manufacturing the magneto-  
resistance device according to claim 26, wherein a  
ratio of a flow rate of the oxygen to a flow rate of  
the inactive gas in said reactive sputtering is equal  
to or less than 0.2.